

REMARKS

In the last Office Action, the Examiner rejected claims 8-27 under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent No. 6,120,140 to Hirosawa et al. ("Hirosawa") in view of applicant's prior art disclosure in Fig. 11 ("APD").

In accordance with the present response, independent claims 8, 14 and 22 have been amended only to incorporate the subject matter of dependent claims 10, 20 and 27, respectively. Claims 9-10, 19-20 and 26-27 have been canceled.

Applicant most respectfully requests entry of the foregoing amendments since they merely comprise the incorporation of dependent claims into corresponding base claims. All of the subject matter of the amended claims has already been considered by the Examiner. Thus, no further consideration or search is necessitated by the amendments. In addition, the amendments substantially narrow any appealable issues because they present the claims in a substantially narrowed form and cancel a significant number of other claims. Thus, entry of the foregoing amendments does not impose a burden on the Examiner and should not be denied.

Brief Summary of the Invention

The present invention is directed to an ink jet head.

As pointed out in applicant's last-filed response, one significant problem with conventional ink jet heads, such as is disclosed in Fig. 11 and pages 1-5 of the specification, is that ink cannot be efficiently discharged from nozzle apertures due to the generation of air bubbles in internal spaces of the ink jet head, including an ink reservoir, common ink chamber and grooves. The air bubbles remaining in the internal spaces of the ink jet head also cause vibrations during operation of the ink jet head. As a result, the conventional ink jet head has poor ink discharge characteristics which reduces the printing quality.

The present invention overcomes this problem in conventional ink jet heads by providing an ink jet head having a construction which prevents degradation of ink discharge characteristics, and thus degradation of the overall printing quality.

In one embodiment according to the present invention embodied in the claims shown in Figs. 2-4B and 8, an ink jet head 20C comprises a substrate 31 having a grooves 33 for receiving ink and extending along a longitudinal direction. A nozzle plate 38 is connected to the substrate 31 and has

nozzle apertures 32 each disposed in communication with respective ones of the grooves 31. An ink storing member (e.g., 60) stores ink to be supplied to the grooves 33. An ink chamber plate 36 is connected to the substrate 31 and has an ink chamber 37 for supplying ink from the ink storing member to the grooves 33.

According to the present invention, a flow path substrate 40C is connected between the ink storing member and the ink chamber plate 36 and contains at least portions of an ink flow path for transporting ink from the ink storing member to the ink chamber 37 of the ink chamber plate 36. The ink flow path has a tubular communicating passage 45, an ink reservoir 41C, an ink introduction passage 49C, and an ink supply passage 50C. The tubular communicating passage 45 has a first end connected to the ink storing member and a second end. The ink reservoir 41C contains a filter 44C which divides the ink reservoir 41C into an upstream space 47C disposed on a lower side of the filter 44C and a downstream space 48C disposed on an upper side of the filter 44C opposite the lower side. The ink introduction passage 49C transports ink along a flow direction generally perpendicular to the longitudinal direction of each of the grooves 33 and has a first end connected to the second end of the tubular communicating passage 45 and a second end connected to the

upstream space 47C. The ink supply passage 50C has a first end connected to the downstream space 48C and a second end connected to the ink chamber plate 36 for supplying ink to the ink chamber 37. The ink supply passage 50C is inclined downwardly relative to a horizontal line disposed generally parallel to the flow direction of ink in the ink introduction passage 49C.

Preferably, each of the ink introduction passage 49C, the ink supply passage 50C, the upstream space 47C, and the downstream space 48C has a thickness smaller than an inner diameter of the tubular communicating passage 45.

By the foregoing constructions, the ink flow path of the ink jet head according to the present invention, as well as the location and orientation of the filter in the ink flow path, the generation of air bubbles within interior spaces of the ink jet head is minimized, thereby suppressing a reduction in the ink flow rate. As a result, degradation of the ink discharge characteristics, and thus degradation of the overall printing quality, of the ink jet head according to the present invention is prevented as compared to the conventional art.

Traversal of Prior Art Rejection

Claims 8, 11-18 and 21-25 were rejected under 35 U.S.C. §103(a) as being unpatentable over Hirose in view of

APD. Applicant respectfully traverses this rejection and submits that the combined teachings of Hirose and APD do not disclose or suggest the subject matter recited in claims 8, 11-18 and 21-25.

It is well settled that the Examiner must satisfy his burden of establishing a prima facie case of obviousness by showing that some objective teaching or suggestion in the applied prior art taken as a whole and/or knowledge generally available to one of ordinary skill in the art would have led that person to the claimed invention, including each and every limitation of the claims, without recourse to the teachings in applicant's disclosure. See, generally, In re Rouffet, 47 USPQ2d 1453, 1456, 1457-1458 (Fed. Cir. 1998); In re Oeticker, 24 USPQ2d 1443, 1446-47 (Fed. Cir. 1992). In this case, the Examiner has failed to carry his burden of making out a prima facie case of obviousness with respect to the subject matter recited in independent claims 8, 14 and 22, which now incorporate the subject matter of canceled dependent claims 10, 20 and 27, respectively, and dependent claims 11-13, 15-18, 21 and 23-25.

Independent claim 8 has been amended to incorporate the subject matter of claim 10 and requires means defining an ink flow path for transporting ink from the ink storing means to the ink chamber of the ink chamber plate, a filter disposed

in the ink flow path in a direction generally perpendicular to the longitudinal direction of each of the grooves, and a flow path substrate connected between the ink storing means and the ink chamber plate, at least portions of the ink flow path being formed in the flowpath substrate. Claim 8 further requires that the ink flow path has a tubular communicating passage having a first end connected to the ink storing means and a second end, an ink reservoir in which the filter is disposed to divide the ink reservoir into an upstream space disposed on a lower side of the filter and a downstream space disposed on an upper side of the filter opposite the lower side, an ink introduction passage for transporting ink along a flow direction generally perpendicular to the longitudinal direction of each of the grooves and having a first end connected to the second end of the tubular communicating passage and a second end connected to the upstream space, and an ink supply passage having a first end connected to the downstream space and a second end connected to the ink chamber plate for supplying ink to the ink chamber. Claim 8 further requires that the ink supply passage is inclined downwardly relative to a horizontal line disposed generally parallel to the flow direction of ink in the ink introduction passage, and that each of the ink introduction passage, the ink supply passage, the upstream space, and the downstream space have a

thickness smaller than an inner diameter of the tubular communicating passage. No corresponding structural combination is disclosed or suggested by the combined teachings of Hirose and APD.

Hirose discloses several embodiments of an ink jet head. In the embodiment shown in Figs. 9-10, which have been reproduced herein as Exhibit A, the ink jet head has an ink flow path for transporting ink from an ink storage portion 41 to an ink ejecting portion 43. A filter 46 is disposed in an ink reservoir L_3 of the ink flow path. At least portions of the ink flow path is formed in a flow path substrate L_1-L_5 , which is connected between the ink storage portion 41 and the ink ejecting portion 43. The ink flow path has a tubular communicating passage L_1 , the ink reservoir L_3 in which the filter 46 is disposed to divide the ink reservoir into an upstream space a (ink storage portion 41 side) and a downstream space b, an ink introduction passage L_2 , and an ink supply passage L_4 .

However, the ink jet head in Figs. 9-10 of Hirose does not disclose or suggest several structural features of the ink jet head explicitly recited in independent claim 8. First, Hirose does not disclose or suggest a filter disposed in the ink flow path in a direction generally perpendicular to the longitudinal direction of each of the grooves, as recited

in amended claim 8. It is unclear whether Hirose discloses any grooves in communication with nozzle apertures of the ink ejecting portion 43 since, as recognized by the Examiner, such grooves are not shown in the drawings nor described in Hirose. However, even assuming that such grooves exist in Hirose, there is absolutely no disclosure of the directional orientation of such grooves. Thus Hirose does not teach disposing the filter 46 in the ink flow path in a direction generally perpendicular to a longitudinal direction of each of the grooves, as recited in claim 8.

Second, Hirose does not disclose or suggest a filter disposed in the ink reservoir to divide the ink reservoir into an upstream space disposed on a lower side of the filter and a downstream space disposed on an upper side of the filter opposite the lower side, as recited in claim 8. With reference to Exhibit A, the filter 46 in Hirose divides the ink reservoir L₁ into the upstream space a (i.e., the space in which ink from the ink storage portion 41 passes before passing through the filter 46) and the downstream space b (i.e., the space in which ink from the ink storage portion 41 passes after passing through the filter 46). However, in Hirose, the upstream space a and the downstream space b are not disposed on a lower side c and an upper side d, respectively, of the filter 46, as required by claim 8.

Stated otherwise, in Hirosawa the upstream space a is disposed on a right side e and the downstream space b is disposed on a left side f of the filter 46.

Third, claim 8 further requires an ink introduction passage for transporting ink along a flow direction generally perpendicular to the longitudinal direction of each of the grooves. As noted above, even assuming that Hirosawa discloses grooves, the reference does not disclose the directional orientation of such grooves. Thus Hirosawa does not teach that the ink introduction passage L_2 transports ink along a flow direction generally perpendicular to the longitudinal direction of each of the grooves, as recited in claim 8.

Fourth, claim 8 further requires that the ink supply passage is inclined downwardly relative to a horizontal line disposed generally parallel to the flow direction of ink in the ink introduction passage. However, as shown in Exhibit A, the ink supply passage L_4 in Hirosawa is clearly not inclined downwardly relative to a horizontal line 1 disposed generally parallel to the flow direction (see arrow in L_2) of ink in the ink introduction passage L_2 . Instead, the ink supply passage L_4 in Hirosawa is parallel to the horizontal line 1 disposed generally parallel to the flow direction of ink in the ink introduction passage L_2 .

Fifth, claim 8 further requires that each of the ink introduction passage, the ink supply passage, the upstream space, and the downstream space have a thickness smaller than an inner diameter of the tubular communicating passage. No corresponding dimensional relationship is disclosed or suggested by Hiroswawa. In Hirowawa, the thickness of each of the ink introduction passage L_2 , the ink supply passage L_4 , the upstream space a , and the downstream space b is either equal to or larger than, not smaller than, the inner diameter of the tubular communicating passage L_1 .

With respect the foregoing fifth feature recited in claim 8, the Examiner contends that it would have been obvious to one of ordinary skill in the art at the time the invention was made to select the dimensional relationship between the thicknesses and diameter of the various portions of the ink flow path as a matter of design choice. Applicant respectfully disagrees with the Examiner's contention.

As disclosed in detail in the specification (pg. 19, line 6 to pg. 20, line 24), the specific dimensional relationship between the inner diameter of the tubular communicating passage and the thickness of each of the ink introduction passage, the ink supply passage, the upstream space, and the downstream space contribute to the effectiveness of applicant's invention. For example, by this

specific dimensional relationship recited in claim 8, volumetric changes of the ink when the ink flows from the tubular communicating passage to the ink introduction passage, the ink supply passage, the upstream space, and the downstream space are effectively reduced, thereby suppressing a reduction in ink flow rate. Thus, in the absence of a teaching basis in the prior art as to the obviousness of these features in the claimed combination, these features must be accorded patentable weight. In Ex parte Dere, 118 USPQ 541, 544 (BPAI), the Board reversed a similar "matter of choice" rejection, stating:

"[W]hy he (Examiner) so holds he does not say and we do not see particularly since only the disclosure of the instant case makes a 'choice' available. In view of the fact that the claimed relationship has the useful advantage already enumerated, we cannot agree with this undocumented statement."

Similarly, in Ex parte Haas, 144 USPQ 98, 99 (BPAI 1964), the Board stated:

"The examiner then says that these are a matter of choice. It is not a matter of choice presented by the prior art. The prior art gives only one choice; a process which will not yield these new and improved results. Thus, one of ordinary skill in the art, turning to the prior art to make his choice, would never arrive at the claimed process."

Thus in order for the Examiner to establish that one of ordinary skill in the art would have modified Hirowawa by choosing a design based on knowledge in the art, the Examiner must advance on the record evidence of that knowledge along with an explanation of why that person would have combined such knowledge with the teachings of Hirosawa in order to make the choice necessary to arrive at the claimed invention. In this respect, applicant respectfully submits that the prior art of record does not disclose or suggest the combination recited in independent claim 8, including the specific dimensional relationship between the inner diameter of the tubular communicating passage and the thickness of each of the ink introduction passage, the ink supply passage, the upstream space, and the downstream space.

Amended independent claim 8 also patentably distinguishes from the embodiments of the ink jet head disclosed in Fig. 3 and Figs. 11-12 of Hirosawa.

In Figs. 11-12 of Hirosawa, the filter 46 is inclined in the ink reservoir L, of the ink flow path. Thus this embodiment of Hirosawa does not disclose or suggest a filter disposed in the ink flow path in a direction generally perpendicular to the longitudinal direction of each of the grooves, as recited in amended claim 8.

Likewise, this embodiment does not disclose or suggest an ink introduction passage for transporting ink along a flow direction generally perpendicular to the longitudinal direction of each of the grooves. As noted above for the embodiment of Figs. 9-10, even assuming that Hirose discloses grooves, the reference does not disclose the directional orientation of such grooves. Thus Hirose does not teach that the ink introduction passage L', transports ink along a flow direction generally perpendicular to the longitudinal direction of each of the grooves, as recited in claim 8.

Moreover, claim 8 requires that each of the ink introduction passage, the ink supply passage, the upstream space, and the downstream space have a thickness smaller than an inner diameter of the tubular communicating passage. No corresponding dimensional relationship is disclosed or suggested by the ink jet head in Figs. 11-12 of Hirose. In Figs. 11-12, the thickness of each of the ink introduction passage L', the ink supply passage L', the upstream space (i.e., the space in which ink from the ink storage portion 41 passes before passing through the filter 46) and the downstream space (i.e., the space in which ink from the ink storage portion 41 passes after passing through the filter 46) is either equal to or larger than, not smaller than, the inner diameter of the tubular communicating passage L'.

Independent claim 8 also patentably distinguishes from the foreign matter removing apparatus disclosed in Fig. 3 of Hirose. As described in Hirose, ink enters the foreign matter removing apparatus through an ink entrance opening 2, passes through a filter 1, and exits through an ink exit opening 3 (col. 2, lines 3-12). The path between the ink entrance opening 2 and the ink exit opening 3 defines an ink flow path.

However, the foreign matter removing apparatus in Fig. 3 of Hirose does not disclose or suggest a filter disposed in the ink flow path in a direction generally perpendicular to the longitudinal direction of each of the grooves, as recited in amended claim 8. The Examiner has not indicated what structure in the foreign matter removing apparatus, or any other structure used in combination with the foreign matter removing apparatus, forms the grooves. Nevertheless, it is clear that neither Fig. 3 of Hirose, nor the corresponding description in the specification, discloses or suggests the specific directional orientation between the filter and the grooves recited in claim 8.

Furthermore, Fig. 3 of Hirose does not disclose or suggest a filter disposed in the ink reservoir to divide the ink reservoir into an upstream space disposed on a lower side of the filter and a downstream space disposed on an upper side

of the filter opposite the lower side, as recited in claim 8. In Fig. 3 of Hirose, the upstream space (i.e., the space in which ink entering the ink entrance opening 2 passes before passing through the filter 1) is disposed on an upper side, not a lower side, of the filter 1, and the downstream space (i.e., the space in which ink entering the ink entrance opening 2 passes after passing through the filter 1) is disposed on a lower side, not an upper side, of the filter 1.

Moreover, Fig. 3 of Hirose does not disclose or suggest an ink introduction passage for transporting ink along a flow direction generally perpendicular to the longitudinal direction of each of the grooves, and an ink supply passage inclined downwardly relative to a horizontal line disposed generally parallel to the flow direction of ink in the ink introduction passage, as recited in claim 8. There is no structure in Fig. 3 of Hirose corresponding to the ink introduction passage and ink supply passage of claim 8.

Likewise, Fig. 3 of Hirose does not disclose or suggest that each of an ink introduction passage, ink supply passage, upstream space, and downstream space has a thickness smaller than an inner diameter of a tubular communicating passage, as recited in claim 8. Again, there is no structure in Fig. 3 of Hirose corresponding to the ink introduction passage, ink supply passage, and tubular communicating passage

and, further, no disclosure of the specific dimensional relationship recited in claim 8.

The Examiner cited applicant's prior art disclosure in Fig. 11 ("APD") for its disclosure of a substrate having a plurality of grooves, a nozzle plate, and an ink chamber plate. However, APD clearly does not disclose or suggest the flow path substrate and its specific structure forming the ink flow path, as recited in amended independent claim 8. Since APD does not disclose or suggests these structural features, it does not cure the deficiencies of Hirose. Accordingly, one of ordinary skill in the art would not have been led to modify the references to attain the claimed subject matter.

Amended independent claims 14 and 22 similarly patentably distinguish from the ink jet head (Figs. 9-10, 11-12) and foreign matter removing apparatus (Fig. 3) disclosed by Hirose.

Amended independent claim 14 is directed to an ink jet head and requires a second substrate connected between the ink storing member and the ink chamber plate, the second substrate having an ink flow path for transporting ink from the ink storing member to the ink chamber of the ink chamber plate and a filter disposed in a portion of the ink flow path in a direction generally perpendicular to the longitudinal direction of each of the grooves, the ink flow path having a

communicating passage having a first end connected to the ink storing member and a second end, an ink reservoir in which the filter is disposed to divide the ink reservoir into an upstream space disposed on a lower side of the filter and a downstream space disposed on an upper side of the filter opposite the lower side, an ink introduction passage for transporting ink along a flow direction generally perpendicular to the longitudinal direction of each of the grooves and having a first end connected to the second end of the communicating passage and a second end connected to the upstream space, and an ink supply passage having a first end connected to the downstream space and a second end connected to the ink chamber plate for supplying ink to the ink chamber, the ink supply passage being inclined downwardly toward the ink chamber of the ink chamber plate relative to a horizontal line disposed generally parallel to the flow direction of ink in the ink introduction passage. No corresponding structural and functional combination is disclosed or suggested by the prior art of record as set forth above for amended independent claim 8.

Amended independent claim 22 is directed to an ink jet head and requires means defining a plurality of parallel grooves each extending along a longitudinal direction for receiving ink stored in an ink storing member, an ink chamber

disposed in communication with the grooves, and an ink flow path for transporting ink to the grooves via an ink chamber, the ink flow path having a communicating passage connected to the ink storing member, an ink introduction passage connected to the communicating passage for transporting ink along a flow direction generally perpendicular to a longitudinal direction of each of the grooves, an ink reservoir connected to the ink introduction passage, and an ink supply passage connected to the ink reservoir for supplying ink to the ink chamber, the ink supply passage being inclined downwardly toward the ink chamber relative to a horizontal line disposed generally parallel to the flow direction of ink in the ink introduction passage; and a filter disposed in the ink reservoir in a direction generally perpendicular to the longitudinal direction of each of the grooves for filtering the ink supplied to the ink chamber. Again, no corresponding structural and functional combination is disclosed or suggested by the prior art of record as set forth above for amended independent claim 8.

Claims 11-13, 15-18, 21 and 23-25 depend on and contain all of the limitations of amended independent claims 8, 14 and 22, respectively, and, therefore, distinguish from the references at least in the same manner as claims 8, 14 and 22.

Applicant most respectfully requests entry of the amendments to the claims since they merely comprise the incorporation of dependent claims 10, 20 and 27 into corresponding base claims 8, 14 and 22, respectively. All of the subject matter of the amended claims has already been considered by the Examiner. Thus, no further consideration or search is necessitated by the amendments. In addition, the amendments substantially narrow any appealable issues because they present the claims in a substantially narrowed form and cancel a significant number of other claims. Thus, entry of the foregoing amendments does not impose a burden on the Examiner and should not be denied.

In view of the foregoing amendments and discussion,
the application is believed to be in allowable form.
Accordingly, entry of this amendment and favorable
reconsideration and allowance of the claims are most
respectfully requested.

Respectfully submitted,

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